30/April/81

Dear Mary,

Thank you for sending me the draft of your paper, which I found waiting for me when I got back to London from an Easter holiday in Scotland. (I read a paper on Bell's Theorem at St Andrews while I was up there!).

new para First of all let me clear up the point about getting too many dead cats.

I will revert to the spin experiment as described on pages 8 and 9 of my EPR paper, since this is what you use on p. 12a of your paper.

Let us denote by ~~[illegible]~~ a variable S_A the setting of the knob on the A-meter, and by S_B the setting of the knob on the B-meter. ~~[illegible]~~ particular values for ~~the variable~~ S_A would be ~~[illegible]~~ the directions $\underline{a}$ and $\underline{a}'$ in my diagram, and for S_B the directions $\underline{b}$ and $\underline{b}'$.

I will use your notation of t_0 = time particles are emitted from source, t_A = the time the A-particle hits the A-meter and t_B = the time the B-particle hits the B-meter and assume $t_B > t_A$. Your claim is that the macroscopic state of the A-meter can be changed at a distance instantaneously and non-locally ~~by~~ at the time t_B by [~~some action performed at B at time t_B~~] performing the measurement at B at time t_B, and ~~And~~ you deduce this from an application of Bell's Theorem.

new para First comment: The nonlocality demonstrated in Bell's theorem is not concerned with performing the measurement at B, but with altering the setting of the B-meter, i.e. changing the value

Important

* I think you are here confusing the case of nonlocality, demonstrated by an application of the 1935 EPR argument, with the violation of locality$_3$ ~~as~~ arising from the Bell argument. Notice how I phrase the formulation of locality$_1$ on p.5 with reference to measurement and of locality$_3$ on p. 8 with reference to the setting of the remote apparatus, in my EPR paper.

Implementation

of the parameter S_B*.

new para In general if a_n is the spin-component of the nth A-particle ~~parallel to a~~ [when ~~the A meter is set~~] parallel to $\underline{a}$ then we can envisage writing a_n quite generally as a function of the QM state Ψ we are in, some 'hidden variable' additional specification λ of the state of the particles coming out of the source, and the settings S_A and S_B.

Display ⇒ Thus

$$a_n = a_n(\Psi, \lambda, S_A, S_B)$$

new para Now Bell's Theorem shows that if Ψ is $\Psi_{singlet}$ for the two spin-$\frac{1}{2}$ particles then a_n must depend on S_B. So if S_B changes from $\underline{a}$ to $\underline{a}'$ some of the a_n's will change from (+1) to (−1) and ~~an~~ an equal number from (−1) to (+1). But this is only true if we change S_B for times between t_0 and t_A. After t_A the state Ψ is no longer $\Psi_{singlet}$, since the mirror-image correlations are destroyed by the interaction of the A-particle with the A-meter at t_A. Compare ~~cf~~ my discussion of the transition from Ψ_i to Ψ_f at top of my p.18 when Ψ changes from Ψ_i to Ψ_f this kills any Conclusion ~~necessary~~ cf a dependence of a_n on S_B by a Bell-type argument. So if at t_B we change S_B from $\underline{a}$ to $\underline{a}'$ this no longer has any effect on a_n and in particular will not cause the spin-meter A to change the reading it recorded at t_A.

new para Applying all this to the case of the cat, QM would not predict that after the control variable c (in point

Question

*(this is an example of the sense in which locality$_4$ gets violated on view A
– see p. 16, para 3 of my paper)

2) of my previous letter) had interacted ~~the~~ with the cat, any further change in the value of C could be effected by moving the lid of the box. I feel that QM would allow us to infer by a reconstructed Bell argument that before C interacted with the cat it could have its value changed by moving the lid. But these changes are such that the number of cats which would have died but are saved * is exactly equal to the number of cats which would not have died but are in fact killed. So we still end up with 50% dead cats.

Suppose, however, per impossibile, that we could change ~~C in after~~ the value of C after its interaction with the cat. ~~Then several two things would happen. A live cat could be killed instantly~~ and allow those revised C-values to interact again with the cat. Then ~~several things would happen.~~ the asymmetry ~~q.v.~~ you refer to would clearly be imposed by the irreversible aspect of the first interaction. Indeed with an ensemble of cats in the box repeated operation of the lid would in the end kill all the cats.

~~My point 2 was not about what QM non-locality predicts~~ This would certainly provide a bizarre version of the Bell telephone!

My point 2) was not that this sort of non locality is predicted by QM (it isn't) but that even if such non-locality did occur it would not enable us to resurrect dead cats.

new para I am thus unhappy with your argument on p. 12a as an additional difficulty for MWI

~~I have already referred to what I regard as the source of the~~

new para You also state on line 7 p. 12a that "Bell's theorem shows there are no deterministic laws ....." But Bell's theorem (in its original version and forgetting about the case of stochastic hidden variable theories – see my note 11) assumes determinism and uses this to demonstrate non-locality.

~~On p. 10 para 2 you ~~don't~~ make it appear clear that that Bell's theorem reflects a difficulty about assigning~~

new para On p. 10, para 2 you do not make it clear that the difficulty for Bell is to assign values to spin components which do not depend on what ~~measurements are being performed~~ sort of measurement is being performed on the other particle, (so the last line here should read ~~'any assignment of local hidden variables~~ ~~'~~ '...... any assignment of locally-determined hidden variables ... ')

new para

On p. 11, para 2 you introduce effectively view B and ~~locality~~ non locality, but since this is directly related to the 'EPR 1935 paper' I feel this interpolation should come directly after your reference to that paper on p. 9, para 2.

new para

~~On p. 11/12~~ At the top of p. 12, I am not clear how the first version of the Arthur and Bernard argument is supposed to function ~~if even if Bernard could tell whether Arthur had measured the x-spin or y-spin on his particle. He would have to tell whether~~ What is Bernard supposed to do to tell whether Arthur has measured the x-spin or y-spin of his particle? There is no way he can find this out whatever measurement he makes just on his particle. Or is this exactly the point you are making? It is not very clear from the phrase 'Bernard does not know which test to . . .'

new para

On p. 10 para 3 and p. 11, para 1 I am unable to follow the argument of 'another suggestion ~~to~~ for evading the EPR paradox'. I am particularly unclear about the reference to 'conspiracies' at the end of this passage. Is there any reference here to what I call Fine's Conspiracy models for evading Bell's theorem referred to on p. 12 of my paper.

new para

A few very minor points:—

p. 4, para 2, line 6: 'one or two sets'. Do you

Trivial

* p. 9, para 2, : Spin-components measured in units of ħ, not explicitly mentioned.

2nd para

not mean two slits which can be opened or closed. rather than 'a few slits' which might be suggested!

new para

p. 8a, line 2 : Do you mean to say 'extra-physical'?

p. 8a, line 4 : 'the early quantum physicists . . .'. Perhaps you should say 'some of . . .', since von Neumann, London and Bauer, for example all subscribed to the effects of consciousness.

X Insertion ⟹

new para

Having made some criticisms of the paper, let me say at once there are many things that I think you put very well, particularly your criticism of Nagel on p. 4. and your whole discussion of the Cat paradox and Wigner Wigner's friend. It is really only pages 9–12a that seem to me to involve some confusions.

With best wishes
Yours
Rudolf